

I M P R O V E M E N T S

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E L E C T R I C I T Y.

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BODY PHYSICIAN TO THEIR IMPERIAL MAJESTIES.

Who was nominated by the President and Council to
profecute Discoveries in Natural History, pursuant to
the Will of the late HENRY BAKER, Esq. F. R. S.

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IMPROVEMENTS IN ELECTRICITY.

BEING appointed to deliver the annual dissertation on some philosophical subject, instituted by our worthy brother the late Mr. HENRY BAKER, I will endeavour to explain some contrivances in electricity which I invented a good while ago, one of which has been much employed, and has undergone several material improvements since I first thought of it.

IT is now about fifteen years ago since I began to make use of flat glasses instead of globes or cylinders, to excite electricity. Finding that a greater quantity of electricity could be excited upon a flat piece of glass, when rubbed on both surfaces, than when it was only exposed to friction on one side; I thought it would be an advantage to substitute a round plate, or disk, of glass, to a globe

or cylinder. I also thought another material advantage might be derived from a plate of glass, as the form of it admits of placing cushions or rubbers upon different parts of it, and taking the electricity, excited by these rubbers, from the interstices between them, which cannot conveniently be done when a globe or cylinder is used. The only inconvenience which I at first conceived would ensue from it was, that the center upon which the plate was to be fixed and whirled round, would always be too near the rubbers (unless these were very short, or the plate of a considerable size) and that these would throw the electricity, collected on the surface of the glass, upon that very center. In order to obviate this difficulty, I proposed to make the center likewise of glass, or some other non-conducting substance, as, for instance, baked wood.

I began first by making use of one of those glass stands, which they call a waiter, and which has a glass support fixed at right angles to its center. I whirled the waiter round as well as I could, rubbing it sometimes on one side, sometimes on both. In this imperfect state I shewed it to Dr. FRANKLIN, who approved much of the scheme, and advised me to pursue it. Soon after, I shewed it to several of my acquaintance, and in a short time I found such machines ready made at Mr. RAMSDEN's and some

other mathematical instrument-maker. Since that time great use has been made of these electrical plate machines throughout Europe, as they were thought by many to be more powerful in a little compass than those with globes and cylinders.

In my travels through different countries, I now and then met with considerable improvements made in them. Abbé FONTANA had contrived one for the cabinet of the great Duke of Tuscany, which consisted of two plates, eighteen inches diameter, fixed to the same center, and each rubbed on both sides on two opposite places. The electrical fire excited on these joint plates, when forced upon a conductor divided in two branches to receive it, was very powerful; so much so, that the conductor, being unable to contain the whole, threw it back upon the brass center; from which it passed to the hand of the operator, and gave him a very disagreeable shock.

Mr. CUTHBERTSON, an ingenious mathematical instrument-maker at Amsterdam, contrived an apparatus with a double plate, by which all the electrical fire collected by the eight cushions was forced upon the conductor, so that none of it could be thrown back upon the center, though made of brass. His contrivance consisted in placing between the glass plates a strong glass ring, about two inches in diameter, so that the brass

center passed through the middle of it. This ring was stuck to the plates with sealing wax or some other non-conducting cement; and the space between the center and the ring was carefully filled with the same non-conducting substance. The conductor had two branches, each of which was placed between the two glasses, reaching very near to the glass ring. By this method all, or almost all, the electricity excited by the eight cushions, was forced to pass upon the conductor, there being no way to reach the brass center, between which and the conductor all communication was cut off by the above mentioned glass ring being filled up with a non-conducting cement. The power of such a machine, notwithstanding that the plates were not above fifteen inches diameter, was very astonishing. I saw one made in London with this improvement (the glass plates being eighteen inches diameter) by which a coated jar of two quarts was fully charged in less than five seconds.

Mr. C. CUYPERS, an ingenious electrician at Delft, has not a little contributed to the improvement of these machines, by making them less liable to be affected by damp weather. This gentleman, considering that all glasses are not equally fit for electricity, and that J. H. WARTZ, and after him Professor MUSSCHENBROEK, were of opinion, that glass, in the composition of which there enters

a great deal of alkaline salt, is very apt to attract moisture from the air, and therefore less proper for electricity (which defect they thought might be corrected by exposing it to a violent and continued heat), took a proper advantage of this knowledge in the improvement of the machines with flat glasses. He found, that glasses, which have been many years exposed to the warm air of a room, very old looking glasses for instance, become by this means much harder, so as better to resist the force of a file; and are then much better for electrical machines: and that such glasses become still incomparably better, if they are exposed to a considerable degree of heat during some months: the heat forcing out of the glass (at least out of its surface) the alkaline salt, not vitrified, which is to be found upon it, and may be known by the taste.

In December 1777 I saw one of these double-plated machines at Mr. CUYPER's house, and found it do admirably well, though the weather was at the time very damp, and the machine kept in a room in which there never was any fire made, and though the cushions had no amalgama upon them: they were made of yellow Turkish leather, stuffed with fine shavings of cork, rammed in them; and had been pressed to give them an equal smooth surface.

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The same gentleman found glassess, prepared in the above mentioned way, far superior in strength to a cake of rosin used in the electrophorus. He published his method in a pamphlet, intituled, *Exposé d'une Methode, par laquelle on rend les Disques de Verre destinés à des Machines Electriques capables d'exciter l'Electricité dans une Air humide, suivi d'une Maniere de faire de très bons coussins pour frotter les Verres des Machines electriques, et de la Description d'un Electrophore perpetuel plus parfait que ceux dont on s'est servi jusq' ici.* A la Haye, 1778.

Those who make use of plate machines should carefully avoid putting the apparatus near the fire, for the purpose of drying or warming it; because the sudden expansion of the glass by the heat cannot so quickly propagate itself through its whole extent; for the center being commonly squeezed between two flat shives of brass, with a piece of leather between the metal and the glass, does not acquire a similar degree of heat at the same time as the rest, and cannot so easily expand; and therefore the plate is in great danger of breaking. If, in consequence of such a blunder, a flaw should happen, its progress might be stopped by drilling a round hole at the extremity of the flaw. These flat glassess may very safely be rubbed with a dry warm cloth.

As the quantity of electricity excited upon glass is nearly in the proportion of the surface exposed to friction; and as glasses of a great size are very precious, and liable to accidents, I conceived, that instead of a disk of flat glass one might substitute one of paste-board, thoroughly imbibed with copal or amber varnish.

To try how this would answer, about seven years ago I ordered three paste-board disks to be made, of four feet in diameter, the distance of six inches from the center being the fittest to give the whole a proper support in whirling it round. When these disks were thoroughly dried and heated, I poured upon them a varnish made of amber dissolved in linseed oil. After they had taken in as much of the varnish as they could imbibe, I covered them with a thick coat of the same varnish, and dried them by the heat of a German stove.

When the varnish was very hard, I found, that even a slight friction with a cat's skin or hare's skin excited a strong electricity upon them.

I then made a frame to place them in, and to whirl them round; which frame was so contrived, that it could contain about twelve such disks, whirling all round on the same center. It consisted of two square pillars of wood, about five feet high, and three inches broad; joined together at top and bottom by a transverse piece
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of wood. In the middle of the two pillars was a hole, about an inch and an half diameter, fitted to receive a wooden axis, which could be placed in, and taken out, at pleasure. Upon this axis were to be stuck the paste-board disks; and a flat board, three inches broad, covered on both sides with flannel, and over this with a hare's skin, was to be placed between each paste-board. The two square pillars were also to be wrapped up first with flannel, and over that with hares skin.

The flat boards, to be placed between the paste-board disks, had each a notch in the center, to give room for the axis to turn round freely. These flat boards could be brought as near one another as was required by two wooden male screws, placed at the upper and lower end of the frame, which reached from one square pillar to the other; which screws were to receive a notch cut out at the upper and under end of each flat board, in order to keep them steady in their vertical situation. A female screw, turning upon these horizontal male screws, was placed between each of the flat boards at their upper and under extremities, and served to bring each of the disks as near in contact with the hares skins as was required to receive a proper friction.

The three paste-boards were fixed in the frame, and whirled round. The electricity excited was so strong
that

that I took sparks between one and two feet long from the front surface of the first disk by approaching my knuckle to it. I then applied a tin conductor to it, about six feet long and six inches diameter, divided into two branches, the extremities of which were furnished with a thick silver lace fringe instead of points. The sparks from this conductor were about four or five inches long, appeared to be very thick, were very brilliant, and so strong, that I did not chuse to receive many of them; nor did those who came to see the machine care to receive more than one. As these sparks succeeded one another at short intervals, I think they would have been much longer if every thing had been adapted for that purpose; as I saw afterwards done at Mr. NAIRNE'S, who contrived to obtain sparks of twenty inches long and upwards from a large glass cylinder.

I considered this paste-board machine rather as a rough sketch of an apparatus, by which I conceived the hope of obtaining an electrical power of almost any degree required, than as a compleat machine. My intention was to find out a contrivance by which a very great quantity of electrical fire might be collected without great expence and without much danger of breaking the apparatus, which two articles cannot be avoided when you make use of uncommon size glass cylinders or disks.

I saw, two years ago, at the Duke of CHAULNES at Paris, an apparatus which had a plate glass five feet diameter. This alone cost him eight hundred French livres.

As I had not adapted the tin conductor to receive the electricity from the three disks, but only from the front disk, I cannot tell whether the force of electricity would have been proportionably stronger if I had made some metallic communication between each of the disks.

I found, that the apparatus, as it was constructed, could not easily have admitted more than three such large disks; for the twelve surfaces exposed to friction being each a foot and an half long, and above three inches broad, made so much resistance to the working of the machine, that it required a strong arm to work it.

Being satisfied with having found that by this, or a contrivance of the same kind, a much greater power could be excited than by the common glass apparatuses; I did not chuse to put myself to more trouble or expence to increase the strength of its frame, or the number of disks.

I must observe, that such a machine may be kept in good order in a heated room; but that it will soon lose its force in countries where it is not the custom to heat rooms as the Germans do. My paste-board disks kept

very good during all the time I left them in a room constantly warmed, which was about two months; but, when they were placed in a cold room, they soon lost their power, having probably attracted moisture from the air. I cannot be sure that the varnish I got made for the purpose was of the best kind: I have reason to suspect the contrary, and therefore I should think that much better might be obtained in London.

Such paste-boards might be possibly preserved from attracting moisture, by keeping them shut up in a box made on purpose, lined within with tinfoil. The moisture might also be expelled again by placing them a good while in a heated room, or upon a baker's oven.

It seems, besides, not improbable, that a kind of paste-board might be made by sticking together the lamina of paper (first thoroughly dried) with a good oil varnish instead of common paste, as this last never can be deprived of its watery particles without losing its cohesive quality. A good kind of paste-board might likewise be contrived by sticking together silk cloth instead of paper.

I contrived a plated machine, the disk of which was made of baked wood and boiled in linseed oil; but it did not answer near so well as the paste-board disks.

I found the paste-board disks not much less susceptible of electricity before I had varnished them than they were afterwards; but they lost their force again in a few minutes, and did not recover it till they were dried and heated again.

It is well known, that writing and brown packing paper, when warmed, may acquire a considerable electrical power by being rubbed with hares skin, a piece of wood, ivory, nay even (as I found by experience) with a metallic body.

As it seems to be a general law of nature, that all resinous bodies, excited either with a positive or a negative electricity, are more tenacious of keeping it, or seem to part with it, as it were, with more reluctance than glass (as I have demonstrated in a paper, read last year before the Royal Society); it is adviseable, that the conductor of such a paper machine be not furnished with metallic points, which being necessarily kept at a distance will not take away all the electricity; but that some flexible, conducting substance, as silver or brass lace fringes, communicating with the conductor, be in close contact with the excited surface.

As woollen cloth or Manchester cotton velvet, and such like substances, excite a good deal of electricity upon dried paper and resinous substances, and do not wear out

so soon as hares skin, it might, perhaps, be found better to substitute them for hares skin.

I have also excited a very considerable electrical force on strong silk velvet, tied upon the circumference of two wooden disks, two feet in diameter, and distant about three feet from one another, fixed upon a wooden axis. The velvet was supported by a strong silk cloth tied under it, in order to give it more strength and steadiness. This machine had the appearance of a drum, and was whirled round, as is usually done with glass cylinders. The rubber was a cushion covered with hares skin.

As silk cloth, and more particularly oiled silk, very easily receives a strong electricity, I make no doubt but a good use might be made of them, by exposing a great surface of them (which may be as large as one pleases) to friction. I have attempted more than one method of constructing such a machine; but as I tried it only in small, I have not pursued the object far enough, and therefore, I think, I have no right to throw out hints unsupported by experience.

